CHEST

Near Hanging
Evaluation and Management

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Prior to the COVID-19 pandemic, the incidence of self-harm was already on the rise. Hanging/suffocation accounted for 50% of the increase in suicide attempts and remains the second leading cause of death from self-harm in the United States. Studies on the management of near-hanging patients are lacking, and most published literature is retrospective. Following airway and circulation assessment, clinical examination and imaging, namely CT angiography, remain the standard for identifying the injuries associated with near hanging: cervical spine fracture, blunt cerebrovascular injury, laryngeal injury, and injury to the trachea and oropharynx. These injuries, however, are uncommon, and each occur in $< 5\%$ of patients in most series. In a large series of critically ill near-hanging patients, $> 50\%$ survived to hospital discharge; however, cardiac arrest predicted a poor outcome. The management of asphyxia-related arrest remains controversial. Targeted temperature management has only been studied in a single large multicenter trial, which was retrospective. Given the significant selection bias of targeted temperature management in the treatment of the most ill patients, no firm recommendations can be made. Finally, for survivors, the underlying mental health issues must be addressed to avoid recurrent suicide attempts. Thirty percent of patients in a large near-hanging series were admitted for their second suicide attempt.

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Self-injury by hanging, otherwise described as "near hanging" if the patient survives to arrival at the ED, is a relatively uncommon trauma mechanism. A retrospective 22-year review at 31 European medical centers included 886 ICU admissions.[1] At one of the busiest trauma centers in North America, 71 cases occurred over an 8-year period.[2] Near hanging is not a mechanism explicitly included in published trauma center triage[3] but may be included by institutional- or regional-level trauma triage criteria. However, this mechanism meets the criteria of other traumatically injured patients: urgent, potentially life-threatening, multisystem injuries requiring an on-site team to make critical decisions and formulate a timely treatment plan that may involve multiple services in a critical care environment.

Suicide attempts and mortality have been increasing in the United States,[4] with suicide surpassing motor vehicle crash mortalities

ABBREVIATIONS: BCVI = blunt cerebrovascular injury; TTM = targeted temperature management

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by 2010.[5] In terms of modality, "hanging/suffocation" accounted for > 50% of the increase in suicides in the period 2000 to 2010[5] and is the second leading mechanism of self-harm in the United States.[6] This phenomenon is not unique to the United States but can be seen worldwide.[7] Furthermore, suicidal ideation and mental illness have experienced a dramatic increase during the past 2 years of the COVID-19 pandemic. The increase in mental health issues and suicides has occurred in pediatrics[8,9] as well as in adults.[10] Given the prevalence and increase of this problem, it is essential that all health care practitioners understand the evaluation and treatment of the near-hanging patient population.

Initial Assessment

Treatment of the near-hanging patient begins with an Advanced Trauma Life Support primary survey with assessment of Airway (A), Breathing (B), and Circulation (C). A patent airway can be rapidly assessed by asking the patient their name. Patients with poor mental status (Glasgow Coma Scale score < 9) and signs of airway compromise or injury should be intubated carefully, with the concern that there could be direct airway injury (eg, laryngeal facture or tracheal trauma). Clinical examination findings that suggest airway injury would include a high-pitched voice, hoarse voice, and inability to manage secretions, as well as subcutaneous emphysema. In a series of near-hanging patients, the risk of laryngeal injury, however, is < 5%.[11] The risk of oropharyngeal is even lower. If intubation is required, it should occur with cervical spine precautions with the assumption that cervical spine fracture and instability are present. Either the cervical collar should remain in place during the procedure or a second practitioner should hold the head in neutral position. A glide scope may facilitate intubation. The intubating practitioner, however, should choose their most facile method for intubation but be prepared to change their approach if securing the airway is challenging, including intubation over a bougie or even a surgical airway.

Once the airway is assessed to be patent or is secured with a cuffed endotracheal tube, respiratory status and circulation are then evaluated. Adjunctive testing with chest wall ultrasound and chest radiograph can be used to determine the presence of a pneumothorax. Once the primary survey is completed, the secondary survey is performed. The secondary survey is a head-to-toe physical examination looking for other signs of injury. Findings on secondary survey in the near-hanging patient may include ligature marks on the neck as well as petechial hemorrhages on the face.[12]

A history should be obtained from the patient or the prehospital ambulance crew to determine whether the near hanging was accidental or intentional. Intentional injury may be complex suicide with more than one suicide modality used; for example, overdose ingestion and hanging.[13] These suicide methods can be chosen simultaneously or one after the other if the first method was unsuccessful. (It is worth noting that this differs from complicated suicide, which occurs due to unintended trauma from a suicide attempt that goes awry.) Complex suicide occurs in < 5% of cases, with most published literature case reports or small case series. Signs of penetrating trauma such as a stab wound should be sought on secondary survey by examining the torso and extremities. If awake and cooperative, the patient should be questioned about access to medications and whether any medications were taken in excess. A postmortem single-city series of hanging cases revealed that nearly 70% had positive serum toxicology findings for licit and illicit drugs.[14] With our toxicology service, we have developed our own institutional approach for the assessment of overdose. Our guidelines include obtaining a serum salicylate level, a serum acetaminophen level, and an ECG to determine the QTc. Treatment of salicylate[15] and acetaminophen[16] overdose is based on serum level. For many other medications, including antipsychotic agents, the treatment of overdose is supportive care as well as bicarbonate for prolonged QTc.[17]

Additional workup for the hanging patient typically includes a CT angiogram of the neck to determine the presence of associated injuries (Table 1)[1,11,18,19]; these injuries are addressed separately in the following sections.

TABLE 1] Injuries and Rates of Occurrence From Near Hanging[1,11,18,19]

Injury	Rate of Occurrence
Anoxic brain injury	8%-35.7%
Cervical spine fracture	2%-6%
Laryngeal fracture	1.4%-5.3%
Tracheal injury	Up to 1.6%
Pharyngeal laceration	Up to 1.6%
Blunt cerebrovascular injury	1.6%-6.1%

Cervical Spine Fracture

Injury to the cervical spine is assumed to be present until proven otherwise, although surprisingly, fractures are uncommon in modern series.[2] A cervical collar should remain in place until the workup is completed. The prehospital extrication collar may remain in place but should be changed to a padded collar within hours to prevent skin breakdown. Even with a padded collar, skin breakdown[20,21] can occur that would meet the Agency for Healthcare Research and Quality Patient Safety Indicator 3 for hospital-acquired pressure ulcer.[22] Many different commercial padded collars exist, with institutional preference determining which one is available for use. Previously, imaging could include either plain film radiography of the cervical spine or CT scans in the alert and stable patient.[23] However, plain film radiography has been shown to be inadequate in adults, with a sensitivity of only 50% for detection of cervical spine fractures.[20] For this reason, as well as the desire to rule out blunt cerebrovascular injury (BCVI) with angiography, imaging of the cervical spine should be performed with a CT scan. In the obtunded patient, controversy remains whether CT scan alone is adequate for cervical spine clearance and removal of the cervical collar.[24]

The classic cervical spine fracture is the hangman's fracture. The hangman's fracture pattern describes bilateral C2 pars interarticularis fractures, a pattern that accounts for up to 20% of all cervical spine fractures and occurs more frequently than other mechanisms such as motor vehicle crashes. A hangman's fracture is typically managed nonoperatively with a rigid orthosis cervical collar and cervical spine precautions. In a single-center series, a review of 10 years of near-hanging patients found that 5% of patients sustained a cervical spine fracture. The type of spine fracture, however, was not described.[11] A retrospective multicenter trial reported 20 (2.9%) cervical spine injuries in 692 patients but also did not report the specific pattern of cervical spine fracture identified.[18]

The hangman's fracture obtained its name from judicial hangings, which, due to the height and force at which they occur, lead to an extension injury: the head snaps back and the chin moves upward. Judicial hangings are considered complete hangings as the height from the fall exceeds the patient's height. All the person's weight is transmitted to the neck as the feet remain suspended above the ground. Classically, the knot of the rope must be under the chin to cause head extension.[12] Most suicide attempts are incomplete hangings, with the height of the fall less than the height of the person and, therefore, do not occur with the same force. Also, the knot is often behind the person's head in suicide and not under the chin, and no head extension occurs. Death is usually by asphyxiation: loss of the airway and cerebral circulation with subsequent cardiac arrest. Patients who recover vital signs usually meet brain death criteria (which vary according to the state and country).[25]

Cervical spine precautions entail wearing the cervical collar at all times; that is, in bed when sleeping and even in the shower. The padding is changed with an assistant when soiled or wet. It is worth noting that cervical spine precautions do not require bedrest or head-of-bed restrictions. A spine surgery consultation should be obtained for any cervical spine fracture that is identified. In the awake and cooperative patient, a neurologic examination should be performed to assess for spinal cord injury, which is reported by some series as occurring in 1% of patients.[18] Spinal shock may be noted on physical examination. In patients with neurologic deficits, this is the clinical loss of motor function, sensation, and reflexes. For spine fractures that lead to a high spinal cord injury (above T6) as would occur from near hanging, neurogenic shock may also be present. Neurogenic shock is the loss of the sympathetic innervation. These patients have hypotension with inappropriate bradycardia (eg, a systolic BP of 60 mm Hg with heart rate of 80 beats/min) and have brisk capillary refill revealing a lack of vasomotor tone on clinical examination. After administration of up to 2 L of lactated Ringer's crystalloid solution, inotropes and/or vasopressors may be administered. Dopamine, norepinephrine, or phenylephrine may be used if there is no sign of hemorrhage. Phenylephrine has only alpha-receptor effects and may improve vasoconstriction and subsequently the patient's BP, at the expense of worsening the bradycardia, however.

Blunt Cerebrovascular Injury

Injury to the carotid or vertebral arteries of the neck is termed BCVI. Many assume these injuries occur from direct vascular perforation from a bone fragment; however, the pathophysiology relates to shear injury. These injuries can therefore occur without an identified cervical spine fracture. Determination of which patients to screen for BCVI remains highly debated. Most recently, some advocate for screening all blunt trauma patients.[26] Risk factors have been identified for BCVI, one of which is hanging that results in anoxic brain

injury.[27,28] Over the last few years, an argument for select screening of near-hanging patients has also been made[19,29]; however, these are all small retrospective studies, and no strong conclusion can be formed. Arterial vascular injuries are graded on a scale of 1 to 5, with low-grade injuries scored as a 1 and the most severe injuries scored as a 5. Low-grade injuries involve the intima, and high-grade injuries lead to occlusion or transection.[30]

The feared complication from BCVI is stroke, which can lead to significant disability or death within 24 h of the traumatic event.[30] CT angiography is the accepted gold standard for diagnosis.[26] Management of BCVI also remains controversial. Fortunately, most injuries are low-grade intimal injuries. Studies comparing aspirin, clopidogrel, and anticoagulation[31] did not show a significant difference in outcome between these therapies. Therefore, aspirin is the most common treatment for low-grade injuries given the risk of hemorrhage in many trauma patients. For higher grade injuries, interventional angiographic procedures may be required. In a retrospective multicenter trial of near-hanging patients, 6.1% of patients had BCVI detected.[18]

Traumatic Brain Injury

With respect to including neuroimaging of the brain, CT scans may be performed at the same time as the cervical spine imaging. Findings at this early point may include edema and loss of gray white matter differentiation, as well as intracranial hemorrhage. In a large retrospective multicenter trial in which MRI and brain CT scan findings were reported, only three of 886 patients had an intracranial hemorrhage.[1] Limited data suggest that CT imaging of the head does not change management, particularly if the patient has a normal mental status (Glasgow Coma Scale score of 15).[32] Less than 3% (four patients) of patients with normal mental status had any intracranial finding in this small series. Only one patient had a traumatic intracranial hemorrhage, but this patient had also been assaulted. In the investigators' review of the National Trauma Databank, a similar correlation was noted: isolated near-hanging patients who had no additional traumatic mechanism and a normal mental status (Glasgow Coma Scale score of 15) had no intracranial injuries.[32]

Laryngeal Injury

Laryngeal injuries include fractures of the hyoid bone, thyroid, or cricoid cartilage. Hyoid bone and thyroid cartilage fractures overall are uncommon from trauma, and therefore limited literature is available. Cricoid cartilage injuries are even less frequent. Symptoms may include changes in voice, dysphagia, pain with coughing, or shortness of breath. Pain and crepitus may be noted on palpation.[33,34]

Laryngeal fracture is reported at variable rates in the near-hanging literature; however, this mechanism places the patient at a higher risk than other traumatically injured patients. The range of injury is from 5%[11] to nearly 40%[35] of near-hanging patients. The most common site of injury was the superior horn of the thyroid cartilage.[35] Unsurprisingly, an autopsy series found a higher rate of injury, although the published rate in the autopsy series is just as variable. Fractures of the hyoid and thyroid cartilage occurred in 15% to 72.5% and 9% to 43% of cases of hanging, respectively.[36-38] These published studies were based on CT scan or autopsy and include $<$ 200 patients each.

One proposed system to classify injuries is based on clinical symptoms and their extent, as well as diagnostic findings.[39] Hyoid fracture management is typically nonoperative. Nonoperative management may include dietary restrictions (liquid or soft diet), placement of a feeding tube, and pain control. Operative strategies are not limited to open reduction and fixation to repair the hyoid but can include the removal of the injured portion of hyoid as well as tracheostomy if respiratory distress occurs.[33] Laryngeal fracture management is dependent on respiratory status as well. Operative management with tracheostomy was more common in a small series in which near hanging was not a common mechanism. All patients requiring a tracheostomy were eventually successful decannulated. All comminuted laryngeal fractures were repaired, and most of these patients did not require a tracheostomy.[34]

Postobstructive Pulmonary Edema

Postobstructive pulmonary edema occurs when patients breath against an occluded airway. Airway occlusion occurs from the noose, and the patient creates significant negative intrathoracic pressure with their respiratory effort. Negative inspiratory pressures as high as –140 cm H_2O have been measured.[40] Although the pathophysiology has not been completely elucidated, fluid rapidly accumulates in the alveolar interstitial space and then within the alveolus.[41] The diagnosis is made based on hypoxia, frothy secretions, and chest radiograph opacification. The treatment includes oxygen supplementation,

relieving the airway occlusion, diuresis to achieve a net negative fluid balance if the patient's cardiovascular status permits, and positive pressure ventilation. Rapid resolution should occur within 48 h.[40]

Cardiac Arrest

The near-hanging victim may experience cardiac arrest. The etiology is typically asphyxiation rather than cardiac in origin. Other etiologies may include high spinal cord injury with involvement of the medulla oblongata and pons, the respiratory centers of the brain. Cardiac arrest portends a poor outcome. A 5-year evaluation of 231 near-hanging patients admitted to an ICU found that 45% had had a cardiac arrest. Ninety-five percent of the cardiac arrest patients did not survive to hospital discharge compared with a 1.6% mortality in the non-cardiac arrest group.[42] Similar findings were found in a large multicenter European study of ICU patients. Four hundred fifty of 886 (50%) experienced a cardiac arrest; 95% of these patients did not survive to hospital discharge.[1] In this study, cardiac arrest was the single largest predictor of mortality.

It remains controversial on how to manage the arrest following return of spontaneous circulation. The literature on targeted temperature management (TTM) relates to cardiac arrest and not asphyxia.[43,44] Prospective studies specifically examining TTM for the patient in respiratory arrest are lacking. A large retrospective multicenter trial examined outcomes in near-hanging patients with arrest. Asphyxia arrest patients who received TTM had worse outcomes (ie, mortality, neurologic outcome) than patients who did not; however, the patients selected for TTM had higher severity of illness.[18] Because this study was retrospective, the time from return of spontaneous circulation to TTM initiation was missing in the majority of patients, and there was variability in the target temperature chosen. The variability in targeted temperature is not surprising as the study included patients from 2005 to 2015, and the recommendations for TTM have changed over time.[45] In the previously discussed multicenter European study, TTM use increased over time from 23% in 1992 to 67% by 2014.[1] No strong recommendations exist for TTM in the near-hanging patient, and prospective studies will be required to a determine which patients may benefit.

Psychiatric Evaluation

Not to be forgotten, management of the patient's underlying psychiatric condition is key. A pre-existing psychiatric diagnosis is present in up to 67% of near-hanging patients.[1,42] In a study based in Northern Ireland, the risk of self-harm following a suicide attempt was 41%.[46] When examining the chance of a second successful suicide attempt, the method of the first attempt is predictive; hanging, strangulation, suffocation is a high-risk factor. More than 50% of near-hanging patients successfully committed suicide on their second attempt in a national Swedish study.[47] Although this study had up to a 31-year follow-up period, most recurrent suicide attempts occurred within 1 year of the first attempt. The initial attempt occurred from 1972 to 1982, and hanging, strangulation, or suffocation accounted for only 1% of all suicide attempts. This study may not be applicable given the difference in suicide methods today. A more contemporary study, from 2000 to 2013, also found that the risk of suicide was highest in the year following the first episode of self-harm. Near hanging was again noted as a high-risk factor.[48]

Conclusions

Near hanging is a mechanism many practitioners will encounter in their careers. The literature on this entity has limited published data, which are mostly retrospective. Institutions should develop their own guidelines based on their available resources and best practices based on the literature to ensure an appropriate evaluation and identify cervical injuries, as well as other possible concomitant suicide mechanisms. Psychiatric evaluation and treatment for survivors are essential to reduce the risk of another self-harm attempt.

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